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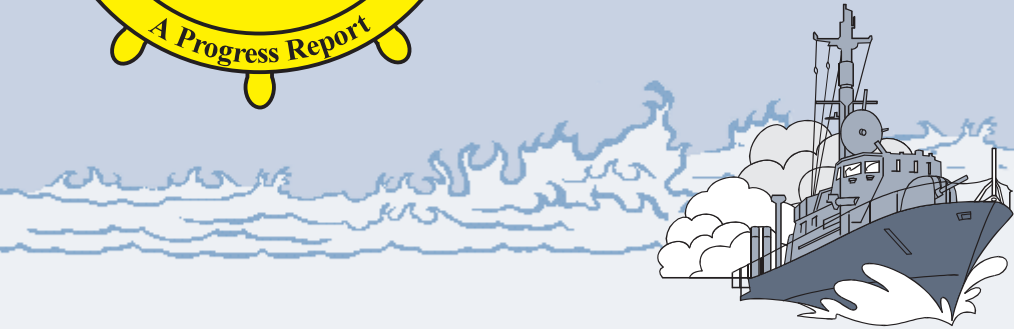

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Equipment Standardization Under Acquisition Reform

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ABSTRACT

This paper discusses the ramifications of current Department of Defense (DoD) Acquisition Reform policies on Navy equipment standardization initiatives and provides an overview of the objectives and benefits of making "best value" end item selections during the design and construction process. The DoD initiative to implement acquisition reform by changing the processes by which defense system and equipment requirements are defined and communicated to contractors is having significant impacts on equipment standardization programs. The emphasis on the use of non-developmental and commercial-off-the-shelf items (NDIs/COTS) combined with naval ship system and equipment requirements being expressed primarily in performance terms creates the potential for the introduction of large numbers of commercial equipment to the supply support system. Approaches to maximizing equipment standardization efforts in the era of commercial-based acquisition strategies are described and examples of standardization approaches using recent ship acquisitions (Strategic Sealift, LHD 1,DDG 51, and LPD 17) are presented.. Possible approaches for the use of performance-based equipment databases and real-time linkages through the Internet with COTS manufacturers are discussed. Impacts that could change the structure of existing logistics support systems and result in substantial improvements in both cost and performance of shipboard equipment and components are addressed.

LIST OF FIGURES

INTRODUCTION

U.S. Navy program managers are finding themselves increasingly under pressure to try new approaches to ensure that their programs are responsive to acquisition reform initiatives. From eliminating or greatly reducing military specifications and standards from design specifications and drawings (1,000 reduced to 143 in the LPD 17 contract design), to distributing streamlined requests for proposals, contracts and contract data requirements electronically (i.e. paperless) over the Internet, the times and the processes by which weapon systems are being procured are drastically changing. "Reinventing Government" initiatives such as the Federal Acquisition Streamlining Act (FASA), which has raised the ceiling for direct purchasing from $25,000 to $100,000, and the Federal Acquisition Computer Network (FACNET), are strong examples of how significant change is being implemented at all levels of the Government acquisition process [1]. Virtually all previous acquisition processes and practices have been under the microscope during the past two years, and those where no value added could be demonstrated have been eliminated. New thinking is encouraged and any and all ideas that may result in reduced acquisition and life cycle costs are being seriously entertained by acquisition program managers.

As witnessed by the DoD/ARPA's's two year acquisition phase Arsenal Ship Program and current planning for the SC 21 Program, gone are multi-year preliminary and contract design phases where NAVSEA design teams supported by contractors would develop extensive (often 1-2 thousand pages) "how to" design specifications with dozens of detailed contract and contract guidance drawings. Existing systems structured for risk avoidance are transforming to a process of risk management that affects all aspects of the weapon systems and platform acquisition process.

Caught squarely in the middle of the acquisition reform process is equipment standardization. For forty-five years, the goal of standardization has been to limit proliferation of items required to be supported in the Navy supply system in order to minimize integrated logistics support costs. Now, under acquisition reform, the focus is on taking advantage of the commercial marketplace, and on affordability, best value, and total ownership cost. The simple message from the Under Secretary of Defense for Acquisition Reform is, "State your requirements in performance terms and let the market respond." Developing and implementing alternatives to the traditional practices in military management and manufacturing standards allows DoD to better use the commercial marketplace and manufacturing base [2]. At the height of the Cold War in the mid-1980's, cost was merely one factor that had to be considered during the design of Navy ships. Now, with the combination of a reduced threat and declining defense acquisition appropriations,

cost, both acquisition and life cycle operation and support, is the primary consideration for acquisition and ship design managers. Cost reduction objectives of 30 percent for acquisition and 70 percent for operational and support ($4 billion target for LPD 17) is forcing NAVSEA decisionmakers to not only "think outside of the envelope," but to use "blue sky" thinking to design new types of envelopes as well. Cost trade-offs must be made at all decision making levels, including at the shipyard engineering working level. Will a $300 commercial-off-the-shelf eye wash unit/combined deluge shower work (meet the performance requirement), or is an $1,800 model required? Will a $175,000 commercial air compressor work, or is a $450,000 MILSPEC-qualified unit required to do the job? Which equipment are truly mission essential? In fact, many concepts under consideration by the SC 21 technical team question which *systems* are essential. Do equipment life cycles need to correspond to the ship's intended service life cycle, or can more affordable equipment be used and replaced periodically? Can COTS equipment and components be used to reduce acquisition costs without compromising mission effectiveness, safety, or shipboard quality of life? What are the logistics impacts of going to a total services contractor approach?

The success of the Navy's standardization initiatives under acquisition reform depend in large part on the ability of program managers, system engineers and designers to answer these types of questions. It will be the job of the cognizant shipyard systems engineer to determine the suitability of commercial equipment applications based on a demonstration of their ability to meet required form, fit, function and performance requirements. Commercial equipment that has been "marinized" may not meet stringent requirements for operation in at-sea combat conditions. Standardization metrics have consistently demonstrated that significant reductions in the proliferation of repairable items combined with commonality-based designs produce substantial cost savings over the life cycle of ships. In addition, new approaches to supply, repair part and logistics support, including total service contractors, are being tried in programs such as Strategic Sealift, and possibly in the major Navy shipbuilding programs for the next ten years, including LPD 17, Arsenal Ship and SC 21.

EQUIPMENT STANDARDIZATION

In its broadest sense, the term "standardization" encompasses a wide range of activities. Standardization includes the development of standards used in acquisitions, use of standard designs, standard administrative and logistical support procedures, and standard equipment, components and non-developmental items. Standardization is not "new business." As one Navy officer recently stated, "We're not doing new things, we're doing old things a new way." The DoD has been trying to achieve a higher degree of acquisition standardization for over forty-five years and has been successful in many cases. However, the Navy's past standardization efforts on which substantial money has been spent have often been directed at reliability problems with specific pieces of equipment [3]. Recent successes include the Navy Pump Reduction Program, the Standard Titanium Fire Pump initiative and numerous Class Standard Equipment (CSE) procurements including cranes, cargo doors and ramps for the Strategic Sealift Program. However, the Navy's Standardization Program has evolved considerably since Public Law 436, "The Defense Cataloging and Standardization Act" was passed in 1952, and now must take into account acquisition reform and commercialization.

Navy Equipment Standardization Efforts -The Defense Cataloging and Standardization Act was intended to provide an economical, efficient and effective supply management organization within the DoD through the establishment of a single supply cataloging system and the standardization of supplies. DoD Directive 4120.3M, "Defense Standardization and Specifications Program Policies, Procedures and Instructions", was developed based on the Standardization Act. In response, the Naval Sea Systems Command (NAVSEA) issued NAVSEAINST 4120.3E in April of 1986. NAVSEA has long been concerned with equipment standardization issues and took action to draft the "NAVSEA Standardization Manual," in September 1980 (NAVSEA Publication 0900-097-1010). In July 1989, the Secretary of Defense unveiled the Defense Management Report (DMR). The DMR concluded that the Government must be more disciplined in what weapons systems it buys and how they are acquired. In addition, the DMR concluded that existing government laws governing acquisition should be clarified in order to provide the DoD broader discretion in making contract awards competitively based not only on cost, but other considerations. DoD Instruction 5000.2 (dated 23 February 1991) Part 6, Section Q "DoD Standardization Program" was developed to attain the goals outlined in the DMR.

To further enhance its Standardization Program, the Navy began the process of reviewing drafts of SECNAVINST 5000.2B "Defense Acquisition", MIL-STD-680B "Standardization Program Requirements for Defense Acquisitions," and NAVSEAINST 4120.6A "Standardization of Components and Equipment" which implement the requirements of the public law, the DMR, and DoDINST 5000.2. SECNAVINST 5000.2B was issued in December of 1996, and MIL-STD-680B was approved and then canceled in June 1995 without replacement, although it may still be used for guidance. The Navy also developed a Standardization Guide Desk Book which conveys the importance of standard part/equipment selection in the design process and summarizes current policies and processes.

Other standards and guidance documents governing standardization policies and affecting standardization under acquisition reform include MIL-STD-965, "Parts Control Program," DoD Publication SD-2, "Buying Commercial and Nondevelopmental Items," and DoD Publication SD-15 "Performance Specification Guide". To comply with public law and current DoD policy, the Navy incorporates standardization initiatives into the entire life of ships, from initial design through construction, operational support, and finally, through decommissioning.

Many programs, such as the LHD 1 and the DDG 51 classes, have achieved high levels (over 90%) of standardization of HM&E repairable items [4]. The CSP/S-24 Strategic Sealift Program contract requirements call for 98% intra-class standardization as measured against the first ship of the class. The "or equal to" criteria for selection of non-standard equipment on Strategic Sealift and LPD 17 class ships includes:

- Technical performance,
- Regulatory Body approval,

- Safety, reliability and maintainability,
- Interoperability,
- Logistic support and survivability.

The success of standardization initiatives affects various Navy activities, including Planning and Engineering for Repair and Alteration Activities (PERAs), Type Commanders (TYCOMs), System Commands (SYSCOMs), In-Service Engineering Activities (ISEAs), and individual ships and the sailors who operate them. RADM R.D. Williams, III, the Navy's Deputy Director of Expeditionary Warfare, reminded the participants at the 1997 Navy Logistics Symposium in Los Angeles that the true customer when making end item selection is "the. 18, 19 and 20 year old sailors who are putting their lives on the line for their country." As described in the following sections, there are numerous DoD and DoN policy and guidance documents that describe the Program Manager's responsibilities for a wide variety of standardization programs, procedures, and initiatives. The following analysis presents the argument that successful standardization is achievable under acquisition reform because requirements stakeholders now have the information tools to take advantage of best value commercial equipment selections and options to apply alternative logistics support processes.

GOALS AND OBJECTIVES

The purpose of Navy standardization is to *reduce total ownership cost* through the selection of equipment and components of proven performance which can be fully supported within the Navy supply system or by the OEM with all necessary spare parts, test equipment, training and technical documentation. Total ownership cost includes both acquisition costs, and operating and support (O&S) costs such as crew, fuel, maintenance and training. As shown in Figure 1, there are approximately 168,000 different HM&E components in the Navy supply support system ($15 billion in Government assets) with an average of 6,000 new repairable items being added each year. The logistics support costs associated with this equipment is approximately $300 million per year. More than 50% of this equipment is installed on five or fewer ships, and approximately 15% of these are one-of-a-kind items.

Excessive quantities of one-of-a-kind and low fleet population equipment with similar functions result in unnecessary logistics support and repair costs. Since all items selected for the lead ship are intended to be standard items for the particular ship and ship class, special emphasis must be placed on determining the quality, reliability, and operational and life cycle support costs for the items selected. If a $100,000 difference exists between ownership costs for a major piece of equipment on a large class purchase such as the DDG 51, the total cost of ownership savings can quickly reach $1,000,000.

Affordability Through Commonality Program -

The primary principle of NAVSEA's Affordability Through Commonality (ATC) Program is that commonality of ship systems and interfaces, and standardization of equipment and components, are essential elements in implementing an effective design-for-affordability process. The goal of this principle is to employ the use of systems, equipment and components, both within ship classes and across ship types, that are standardized to the maximum extent practicable. As Grigg [5] notes, standardization ideas (and goals) are dependent on the expected benefit or motivation behind the standardization effort. Equipment standardization is aimed primarily at reducing logistic costs. Intra-ship standardization is aimed at increasing operational readiness by increasing the interchangeability of spare parts. The primary objectives of the ATC Standardization Program are:

- To reduce costs including manpower costs needed to operate and maintain ship systems,
- To reduce acquisition costs through the use of common Fleet-wide equipment,
- To optimize the variety of items used in logistics support in order to enhance interchangeability, reliability, maintainability, and availability;
- To improve the operational readiness of ships, and
- To ensure that products of requisite quality are procured that meet performance, form, fit, function, safety and environmental requirements.

The first tier objective is to ensure the use of common equipment for similar functions on the ship (intra-ship standardization). The second tier objective is to attain the maximum level of interchangeability of equipment and components by reducing the number of unique items installed within the ship class (intra-class standardization). The third tier objective is to obtain standardization with existing supported equipment and components in the Fleet while meeting performance and other requirements (intra-Fleet standardization). In addition, objectives at all levels include limiting the range of different types of equipment and components used, and provisioning for the maximum use of common maintenance, fault diagnostic, test and support equipment and training material.

As stated in the NAVSEALOGCEN Guide to Standardization, the benefits of maximizing the use of standard designs and equipment are intuitive. From a total ownership cost perspective, the use of standard components reduces both product acquisition and life cycle costs by:

- Allowing for economies of scale from large purchase orders,
- Minimizing the need for development of new provisioning technical documentation,
- Reducing the number of purchase orders that need to be processed,
- Reducing warehousing costs through decreased stocks of spare parts,
- Reducing required capital investment costs for developmental items, and
- Reducing the need for training associated with new equipment introductions.

BARRIERS TO STANDARDIZATION

Regardless of whether Navy standard or COTS equipment and components are selected as class standard equipment during ship design, there are numerous barriers to achieving standardization objectives, including the following:

Length of Time Between Shipbuilding Programs - A major Navy ship design and production program can take as many as ten years or more from concept to commissioning. During this

time, equipment specified for procurement may no longer be manufactured or supported by the original equipment manufacturer (OEM), and newer, more cost responsive, efficient and reliable models may become available. However, there are numerous acquisition reform and ship design improvement initiatives underway in the Navy shipbuilding community to dramatically decrease the concept to commissioning timeline.

Manufacturer Turnover - There is considerable turnover among OEMs resulting from going out of business entirely or from mergers and buy-outs. The discontinuation of manufacturing lines and cancellation of repair parts support contracts prevents effective long-term standardization.

Obsolescence - Equipment and components, and especially electrical and electronic items, are subject to obsolescence due to rapidly advancing technologies that provide increased performance and cost efficiencies.

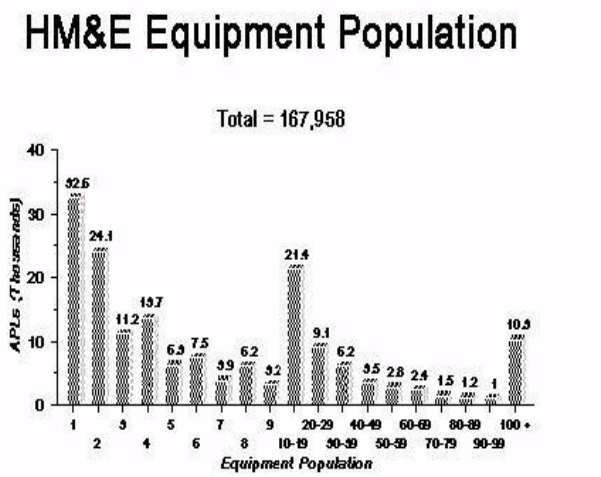

Figure 1 - HM&E Equipment Population

To a lesser extent, this is true with HM&E items as continuous improvements are made to equipment which change their configuration, and hence their technical data package, which generates a new Allowance Parts List (APL) number in the Navy logistics support system.

Lack of Acquisition Incentives - Unless a shipbuilder is contractually obligated or provided incentives to purchase standard equipment, equipment awards will go to the low bidder or to regional suppliers. In the past, this has often resulted in thousands of new items being unnecessarily introduced to the Navy supply support system. The key to maximizing standardization is to seek and obtain long term partnerships with proven quality performance OEMs and vendors who are committed to providing reliable commercial repair parts supply support.

Navy Market Share - The Navy's influence on the commercial market has been in decline for several years. Although the Navy's share of the shipbuilding market in the United States is significant, in relationship to the world market it is not. In particular, the Navy's share of the marine equipment market is not significant enough to influence many manufacturers or vendors other than those who make Navy-unique equipment such as replenishment and fueling-at-sea systems, and items built specifically for combat systems that must withstand grade A shock and meet stringent vibration requirements.

Lack of Engineering Awareness - Many working level engineers are simply not aware of the impacts of non-standard equipment selections on logistics support activities. For example, the average ILS cost for the introduction of a new pump is approximately $63,000 and this figure excludes the price of training, which can run into the tens of thousands of dollars depending on the complexity of the unit.

Lack of Data Access and Communication - In order to ensure that the maximum benefits of standardization are realized, systems engineers must have ready access to current and accurate commercial and Navy standard equipment performance, logistics and cost data that will enable them to quantifiably measure cost avoidance and projected return on investment.

TYPES OF STANDARDIZATION

Standardization is defined by the DoN's Office of the Assistant Secretary for Research, Development and Acquisition (ASN(RDA)) as the process used to achieve the greatest practicable uniformity of items of supply and engineering practices, to ensure the minimum feasible variety of such items and optimum interchangability of technical information, training, equipment parts and components. The term "standardization" means maximizing the uniformity of equipment and components used in systems to reduce total ownership costs. For the purpose of clarifying terminology, "standard" equipment can be considered from several different viewpoints.

Navy Standard Equipment - Navy standard equipment are those items for which the Navy owns all technical data rights including Level III manufacturing drawings. There are approximately forty different Navy standard equipment technical data packages. Examples of Navy standard equipment include the Standard Navy Fire Pump and the STAR low pressure air compressor. However, a major objective of acquisition reform is to reduce or eliminate the need for the Government to maintain configuration control of technical data packages such as these. Current funding levels reflect declining intent to develop new Navy standard equipment data packages.

Equipment Built To Standards - Equipment may be built specifically to meet either Military (MILSPEC) or commercial (ASTM/ANSI) standards. However, under acquisition reform initiatives, the use of MILSPEC equipment is limited to applications where no commercial alternative exists, where use of the commercial equipment is not the most cost responsive approach, or where the MILSPEC equipment is the commercial standard. DoD Directive 5000.2 provides clear direction in terms of the use of commercial and non-developmental items. The Directive states that non-Governmental standards and commercial item descriptions must be used in preference to Federal and military specifications and standards whenever practicable. The Directive's mandate for the use of non-developmental items is that they should be incorporated into the design and development process consistent with operational requirements. A key element of this approach is to ensure that market research and analysis is conducted to determine the suitability and availability of an item

prior to the commencement of a developmental effort. Compounding this problem, there is a real scarcity of commercial standards that apply to marine industry equipment and components.

Standard (supported) Equipment - Standard equipment is any equipment listed in the Navy's Hull, Mechanical and Electrical Equipment Data Research System (HEDRS) database that has already been through the logistics provisioning process and is still supported by the OEM. Standard equipment may be built to either military or commercial standards, and in many cases, the military standard is the commercial standard. However, due to the large numbers of one-of-a-kind equipment in the Fleet, special preference should not necessarily be given to standard equipment over COTS equipment unless the total ownership cost analysis indicates the standard equipment to be the best value selection for the Government. Items listed in the HEDRS database are considered non-developmental items, but not necessarily COTS.

New Commercial Standard Equipment - Use of COTS items may be necessary and/or desirable under certain circumstances, including when:

- There is no standard equipment or component available that meets the performance requirements,
- Specified performance requirements cannot be modified to allow use of standard components,
- Suitable standard equipment or components cannot be supplied in time to meet ship construction schedules, and
- A total ownership cost analysis indicates that a new commercial item would provide significant design and cost advantages without compromising performance, or form, fit and function requirements.

NAVY NDI/COTS POLICY

The Acquisition Reform Office (ARO) of the DoN is the focal point for matters pertaining to the management and execution of the Navy Acquisition Reform Program. The ARO provides counsel to the ASN(RDA), and coordinates various DoN Acquisition Reform Program initiatives. The underlying objectives of the Navy's ARO are to reduce costs of DoN acquisition and ownership, reduce the cycle time between identification of requirements and delivery of products, and transition to an integrated national industrial base sustained predominately by commercial activity which is capable of providing superior military products of high quality.

The ARO philosophy for achieving acquisition reform is to re-engineer the process by which the DoN conducts business. This re-engineering is the focus of the acquisition reform program. The ARO defines acquisition reform as "a program to achieve DoD's military superiority objective at reduced cost with increased responsiveness to customers." Key elements of the ARO's strategy are to integrate the military and commercial industrial base, increase innovation, foster managed risk, encourage empowerment, and establish cross-functional teams using world-class commercial practices. The ARO defines their mission as nothing short of "changing the culture of the current acquisition environment to give program managers the freedom to succeed". The ARO vision is that this fundamental cultural change will be supported by world class communications that allow exploiting the proliferation of information technologies and allow real-time participation in innovative product and process demonstrations. The ARO also envisions virtual workplaces where new process concepts are tested and applied to programs and "exploitation" of modeling and simulation technologies including high performance computing, high bandwidth networks and large object-oriented databases. The objective of the ARO's philosophy is to achieve "world class" status in both acquisition processes and the products that are procured. A key element of the new DoD acquisition culture is that it is dynamic in nature: The ARO states that organizational and management structures will be used to continually adapt processes and methods to match changing demands, and that management networks will be used to collaborate interactively among supplier, producer, and customer teams to create world class products and services.

The Federal Acquisition Streamlining Act requires that in defining requirements, preference must first be given to the use of commercial items, and second to the use of other types of non-developmental items. The overarching goal of Navy policy on the use of COTS and NDIs is to use commercial items to fill requirements to the greatest extent practicable. The Supportability Policy for Navy Implementation of Department of Defense Acquisition Reform initiatives recognizes the difficulty in achieving standardization under acquisition reform: "Achieving standardization is often in direct opposition to the use of performance specifications and commercial-off-the-shelf items. It is necessary to obtain a balance between these two ends of the spectrum by using good business and technical judgment in determining the best approach to reduce the total cost of ownership." In addition, the policies governing existing approaches to equipment procurement recognize the need for innovative approaches to logistics support. The Navy Guide to Standardization recognizes the difficulty of standardization under acquisition reform, but is firm in its conviction that it is achievable. The guide states that achieving standardization and using NDI/COTS equipment can be accomplished together in the same acquisition, but that the Program Manager must resolve all supportability issues before selecting an NDI/COTS equipment. Resolving these issues assures the Program Manger of achieving standardization and NDI/COTS requirements, and meeting the needs of the Fleet. Supportability includes the capability to purchase the item from the manufacturer now and in the future, and providing support to Fleet users of the item whenever and wherever support is required. It is the Program Manager's responsibility to analyze the acceptability of the performance of the item, the item's total life cycle cost, and the cost effectiveness to the Government.

Elements of Effective Standardization - The ATC Standardization Team has identified four primary keys to successful standardization. The first is that effective equipment, component and piece part standardization begins with the working engineer who is responsible for requirements definition and equipment selection during the design phase of the ship acquisition process (***buy the right one first***). The second is that maximizing the benefits of equipment standardization requires long term commitments to original equipment manufacturers who both warrant and agree to support their products and provide commercial logistics support as ***needed (Quality partnerships)***. Innovative quality partnerships such as the Naval Material Quality Assessment Office's "Red/Yellow/Green" Program, where the Government works with vendors to improve quality, combined with long term vendor/supplier relationships are essential ingredients to successful equipment standardization under acquisition reform. The third is that the use of equipment packaged units and modules comprised of standard equipment families will accelerate the return on investment from standardization initiatives (***economy of scale***). The fourth is that the use of electronic tools such as NAVSEALOGCEN's HEDRS, Product Deficiency Reporting Evaluation Program (PDREP), Open Architectural Retrieval System (OARS), Configuration Data Managers Database Open Architecture (CDMD-OA), and NAVSEA's Ship Equipment Attributes - Logistics Information Network (SEA-LINk) are essential tools for efficiently and accurately identifying, locating and communicating end item design and procurement data (***who's selling what, how good is it, can it be supported long term, and does it reduce ownership costs?)***.

Performance Requirements \ COTS Candidates	Marconi	Interstate	Matnavox #1	Matnavox #2	Motorola	Collins #1	Collins #2	Stanford	Texas Instr.	Tracor	Trimble Navpak	Remarks
Battery Power	√	√	√	√	√	√	√	√	√	√	√	* Add-on
Waypoints	x	√	√	√	x	√	x	√	√	√	√	
MGRS	x	√	√	√	√	√	x	x	√	x	√	
Lat/Long	√	√	√	√	√	√	√	√	√	√	√	
UTM	√	√	√	√	√	√	x	√	√	√	√	
SEP<100M	30	51	100	17	25	16	25	14	16	100	43	accuracy
<10 lbs.	5	10	9.5	29	7	17.5	9.9	7.5	9.8	7.7	5	weight
User Friendly	x	x	√	√	√	x	√	√	√	√	√	field test
Self Training	x	x	√	√	√	x	√	√	√	√	√	field test
25m/sec	?	√	√	√	√	√	√	√	√	√	√	
5 m/sec²	?	√	√	√	√	√	√	√	√	√	√	
Built-in-Display	√	√	√	√	x	√	√	√	√	√	√	
Malfunc. Ind.	?	√	√	√	√	√	x	√	√	√	√	
160 ° Conical	?	√	√	√	√	√	√	√	√	√	√	
Cost	?	$9.5K	$4.9K	$7.8K	$10.0K	$24.5K	$14.0K	$20.0K	$15.0K	$9.7K	$4.7K	

Legend: √ = Meets requirement x = Does not meet requirement ? = Information not provided

Figure 2 - COTS Market Survey

Non-developmental Items - "Non-developmental item" is a statutory term describing items that have been previously developed for production. Any previously developed item used exclusively for government purposes by a Federal agency, a State or local government, or a foreign government with which the U.S. has a mutual defense cooperation agreement, is considered an NDI. For example, the mechanical dereefer used with the U.S. Army's cargo parachutes was developed for and first used by the Canadian army. Non-developmental items (NDIs) include items previously developed for use in the Fleet or by other DoD activities and Government agencies. NDIs include items obtained from a domestic or foreign commercial marketplace.

Commercial Items - Commercial items are defined as "any item, other than real property, that is of a type customarily used for non-Governmental purposes, and that has been sold, leased, or licensed to the general public, or has been offered for sale, lease, or license to the general public" [6]. An item is considered a "commercial" product if it is customarily used by the general public and has a commercial sales history, is listed in catalogs or brochures, has an established price and is readily available to the general public. New items that have just been introduced to the market and items that are intended to be available at the time of ship construction are considered commercial items as well. Commercial items can also be the product of integrating commercial subsystems and components into unique systems. Industrial plant equipment that combines commercial components into a unique system based on the Navy's needs is one example, as is a computer system comprised of commercial subsystems that are integrated into one system.

The Program Manager's Role - The Program Manager's role in implementing commercial standardization strategies under Acquisition Reform is critical in determining the extent that NDI/COTS are applied throughout the acquisition process. The ARO emphasizes that Program Managers must incorporate effective communications networks to optimize their Integrated Product Team's (IPT) ability to analyze the total operational and support life cycle impacts of using a COTS item [7]. In addition to assessing factors such as environmental impacts and costs of disposal, IPTs are required to determine which item or items meet logistics support program plan requirements and to determine the cost benefits to the Government. The IPTs must identify one-to-one equipment substitution where COTS items meet specified form, fit, function and performance requirements, *and* consider if a commercial item can be modified to meet the requirements. IPTs must also consider if the requirements themselves can be adjusted to accommodate use of the item without significantly degrading overall system performance. The Navy Standardization Guide addresses this issue by advising that if no COTS equipment is

suitable, then the issue of modifying an existing commercial item must be addressed. Any use of COTS items or modified COTS items may also result in the Program Manager having to reduce or relax (i.e., trade-off) non-critical requirements in order to increase the pool of qualified, available COTS items. Some COTS items such as workshop equipment are already developed for heavy-duty industrial applications and harsh environments and often meet specified requirements without modification, including stringent shock and vibration standards.

The DoD Acquisition Management Policies and Procedures states that programs using commercial systems or equipment should make maximum use of existing logistics support and data. Development of new organic logistics elements will be based on critical mission need or substantial cost savings, or both. The DoD acknowledges that it may be necessary to modify existing logistics support procedures to allow for maximum use of COTS items. This approach necessitates innovative repair parts supply concepts to be developed that support accelerated integrated logistics planning schedules and require acquisition techniques such as buyouts, warranties, and data rights escrow in order to mitigate technical and support risks. Commercial logistics support also requires long term (at least the life cycle of the equipment) vendor contracts to ensure adequate sparing for items not in the Navy supply support system.

BEST VALUE EQUIPMENT SELECTION

The first step in completing a best value equipment analysis is to identify the COTS items that are readily available on the market that meet the required performance characteristics. This requires an in-depth market survey using a methodology similar to that shown in Figure 2 for a Global Positioning System. In order to be in compliance with acquisition reform directives, particular care must be taken to avoid listing "how to" design requirements and to include only performance, form, fit and function requirements. However, a short term increase in the numbers of COTS items that become "new standard" equipment requiring support may be necessary in order to obtain long term reductions in the total numbers of different APL-worthy items in the Navy supply support system.

Although it is clear that acquisition reform policy makes COTS items the first order of preference, the selection of COTS equipment is not necessarily the best value equipment option for the Government. Cost avoidance from the procurement of functionally interchangeable commercial HM&E equipment is equal to the actual savings resulting from the least cost equipment procurement minus the costs incurred from increased logistics and infrastructure support of the additional item.

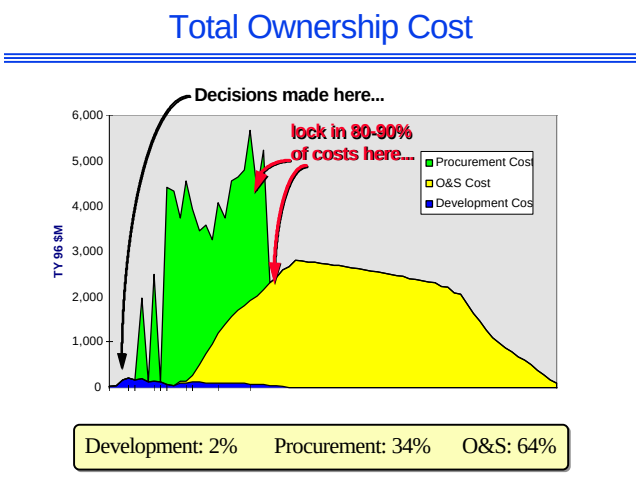

Figure 4- Total Ownership Cost

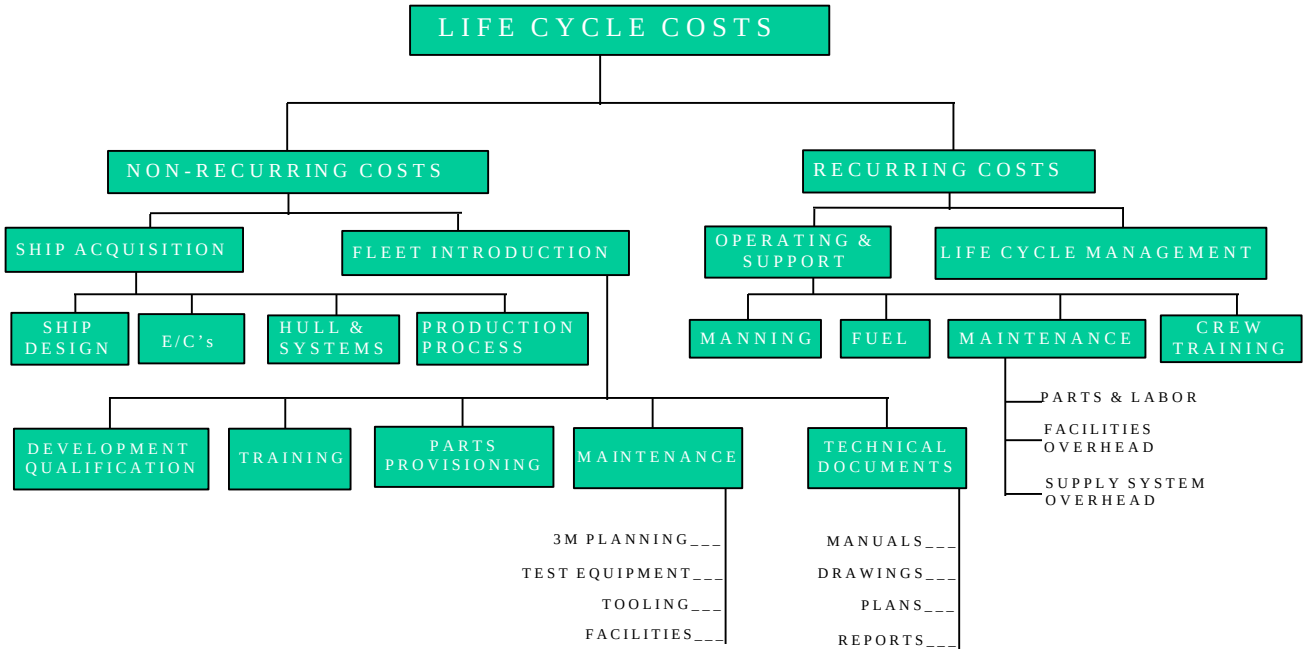

Figure 3- Life Cycle Cost

Life Cycle Costs - As illustrated in Figure 3, NAVSEA 017 considers two types of life cycle costs (LCC); Non-Recurring Costs, and Recurring Costs. Non-recurring costs include factors such as the cost of the ship design, parts provisioning, and purchasing technical manuals and test equipment. Recurring costs include factors such as manning, fuel, crew training, maintenance and repair.

Total Ownership Cost - Initial acquisition cost is only one of many factors that need to be considered in making equipment selection decisions**.** As shown in Figure 4, the majority of total end item costs are incurred during the operational and support phases of an equipment's life cycle. The initial development and procurement cost of a repairable (maintenance-significant) end item typically comprises only about 36% of the total ownership cost (TOC) with the remaining 64% accrued during the operational and support phase of the item. As a result, 80 to 90 percent of an item's TOC is determined prior to ship deployment. In order for reductions in TOC resultant from standardization to be calculated accurately, the costs associated with the different phases of an acquisition project, from concept development through crew training, maintenance and logistics support need to be considered [8]. True TOC also includes the cost of end item disposal as well. Standardization of NDI and COTS items can contribute significantly to reducing TOCs, including:

- Maintenance and repair parts costs (fewer support parts are needed),
- Stowage costs (fewer Coordinated Shipboard Allowance List (COSAL) items onboard),
- Training costs are reduced (interchangability is enhanced and fewer items are required to be purchased for training purposes),
- Provisioning and administrative and management costs (fewer supply support items need to be procured and fewer APLs and NSNs need to be developed and maintained),
- Configuration control costs (fewer types of items need to be tracked),
- Installation and interface control drawing maintenance costs (fewer drawings), and
- Provisioning costs (fewer numbers of provisioning parts technical packages need be prepared).

Affordability Analysis Methodology - There are numerous measures of affordability including average acquisition cost, life cycle cost, acquisition rate, discounted and non-discounted affordable fleet size, and force levels for specified budget and ship life. Rains [9] has outlined an effective approach for cost analysis methodology within which standardization

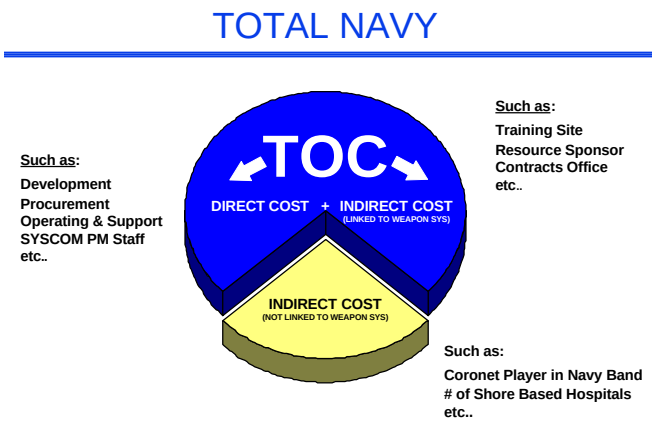

Figure 5 - Direct and Indirect Costs

affordability factors can be considered. Affordability analysis for equipment standardization requires considering TOC as a set value for each equipment when used in the analysis.

Specific Cost Factors - Optimizing equipment operating economies is a central element of achieving effective standardization. Life cycles of equipment typically range from a minimum of five years to as
many as forty years (the ship's life cycle). Factors such as the cost of maintenance-significant piece parts (especially those designated for inclusion on the COSAL), the cost of provisioning, and the cost for National Stock Number (NSN) maintenance must be considered during the equipment selection process. Direct and indirect life cycle support cost percentages are illustrated in Figure 5.

In addition to acquisition costs, the following ILS elements must be considered in the total cost of ownership equation (as applicable to the specific equipment under consideration for standardization and tailored to the particular acquisition strategy):

Cost of Provisioning - Provisioning is the process of developing support for new equipment and consists of cataloging parts, procurement of supply support items, developing maintenance philosophies and computerizing support data. The data developed during provisioning is used to develop an Allowance Parts List (APL) which describes required maintenance and parts support. A National Stock Number (NSN) is assigned to the item and an annual cost of management for maintaining the item in the Government supply system is assigned by NAVSEALOGCEN.

Cost of National Stock Number (NSN) and Allowance Part List (APL) Maintenance - The cost of NSN and APL number maintenance is related to the administrative and management costs associated with maintaining the supply support system. This cost is dependent on the type of equipment (its complexity) and the projected life cycle (duration) over which the item will be required to be tracked by the system. The average cost of maintaining an item in the supply system is approximately $500 per year.

Cost of Training - Training costs include costs for students, instructors, training aids, tools, and support equipment, and costs associated with course materials, training site operation, and travel and administration. In addition, the cost of technical review of new course material and liaison with manufacturing representatives must be accounted for. The Management Consulting Directorate of the Office of the Auditor General of the Navy estimates this cost to be at least $2,000 per item. Training costs also can impact procurement if one or more items require purchasing for land-based training facilities.

Cost of Installation Drawing Changes - Variations in form and fit between the original standard or installed equipment and the COTS item may result in the need to modify installation control drawings. The cost of installation control drawings is estimated to be $1,000 per item by NAVSEALOGCEN.

Cost of Technical Manuals - The practice of developing technical manuals in accordance with a strict, Government-only Contract Data Requirements List (CDRL) is gradually giving way to the acceptance and use of COTS technical manuals except for Navy-unique developmental items and systems. For the purpose of calculating COTS technical manual costs, $0 is assumed to be applied.

Cost of Planned Maintenance - The life cycle cost of planned maintenance is estimated by NAVSEALOGCEN to be an average of $500 per equipment.

Cost of Planned Repairs - The cost of planned repairs due to piece part replacement is dependent on the inherent reliability and mean time between failure for each item and must be calculated independently to determine a value for the equipment under consideration for standardization.

Cost of Disposal - The estimated cost of disposal of the end item must also be considered in determining ownership costs, especially costs associated with disposal of any hazardous wastes that may be required.

Cost of Configuration Control - Configuration control cost includes identification of equipment for COSAL development and is dependent on the complexity of the item. For example, the configuration control cost could be as low as $164 for a capstan, and as high as $5,372 for a circuit breaker. Configuration control costs are even higher for more complex equipment.

STANDARDIZATION TOOLS

NAVSEA ship design managers and system engineers must have timely and rapid access to logistics cost data and analysis information that are necessary to successfully obtain the balance between traditional standardization objectives (minimizing the proliferation of items that need support) and standardization under acquisition reform (taking advantage of commercial market technologies and attractive procurement opportunities). The need for an extensive equipment design and life cycle cost information database recommended by Dickenson [10] has now become a reality as NAVSEA and NAVSEALOGCEN have both launched highly effective online equipment information database systems. Due to the large numbers of items and equipment subject to standardization and commonality, access to various database systems is required to provide critical component performance characteristics, logistics and cost information to the cognizant engineer. A typical Navy combatant has approximately three to four thousand different types of repairable equipment installed. Tools such as the Internet are now increasing the ability of designers, logisticians and purchasing department personnel to rapidly obtain accurate product data. As described in the following paragraphs, the primary database tools currently being used are HEDRS, PDREP, CDMD-OA, OARS and SEA-LINk, each of which provides critical information to the equipment selection decision maker.

Hull, Mechanical and Electrical Equipment Data Research System (HEDRS) - The Navy's primary tool for accomplishing HM&E Standardization during the 1990's has been HEDRS, developed and managed by NAVSEALOGCEN. The HEDRS database is an unclassified Compact Disk-Read Only Memory (CD-ROM) listing of approximately 168,000 HM&E items installed in the fleet. All of the equipment listed in HEDRS are NDI. HEDRS is a compilation of databases that consists of four parts:

(1) A Components Characteristics File (CCF),
(2) An Equipment Applications File,
(3) A Supportability Database, and
(4) An Integrated Logistics Support Database.

The ILS database function of HEDRS reports whether ILS data has been developed for the particular equipment. HEDRS also contains data regarding equipment fleet populations and is scheduled to include average repair and maintenance cost data in its next release. The CCF describes form, fit and function

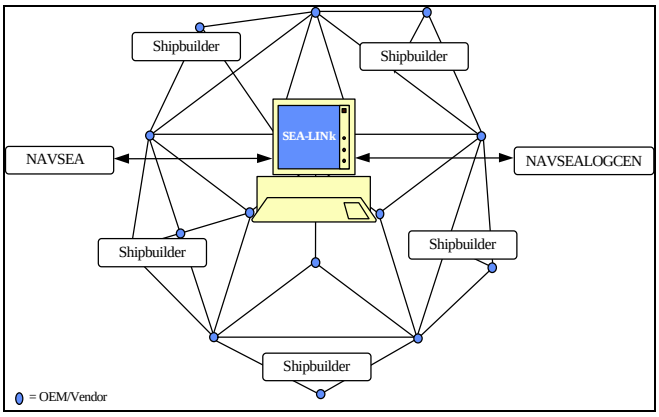

Figure 6- SEA-LINk Electronic Network

attributes and is indexed by APL numbers. The equipment applications file documents where within a particular ship the equipment is installed. Supportability information is derived from a manufacturers survey conducted every two to three years and is expressed in terms of an Engineering Support Code (ESC). An ESC of "A" means that the item is fully supported by the manufacturer for both initial procurement and for repair parts. An ESC of "B" means that the end item is obsolescent (is no longer supported or cannot be procured).

Product Deficiency Reporting Evaluation Program (PDREP) - PDREP is a NAVSEALOGCENDET Portsmouth, New Hampshire, centralized reporting system which provides quality assurance data collected from all Navy SYSCOMs. The PDREP system contains deficiency reports on new and newly reworked material, relevant contractor evaluation data and contract information, surveys and test reports. The system allows users to generate Contractor Evaluation System (CES) and Quality Deficiency Reports (QDR). PDREP uses a "Red/Yellow/Green" ranking system to identify manufacturer quality deficiencies.

Configuration Data Managers Database Open Architecture (CDMD-OA) - CDMD-OA is a NAVSEA 04TD initiated data system developed to allow shore- based Configuration Data Managers (CDM) to track the status and maintenance of naval equipment and their related logistics items (drawings, manuals, etc.) on ships and naval activities around the world. The purpose of CDMD-OA is to reduce the dataflow lag time between the ship, the CDM, and the Naval Inventory Control Point. CDMD-OA uses INMARSAT satellite transmissions and high speed Internet connections via the NAVSEA Enterprise-Wide Network (NEWNET). CDMD-OA provides a single repository of all Naval configuration and logistics data from around the world.

Open Architectural Retrieval System (OARS) - OARS Version 2.1 was released in May of 1996 and is a Windows-based, desktop tool developed by NAVSEALOGCEN which allows NAVSEA engineers to quickly and easily generate standard and ad hoc reports. The types of reports include the Parts Issued for Maintenance Detailed Report, Ships' 3-M History, and System Performance and Readiness Improvement Through Technical Evaluation Reports. OARS can access any Structured Query Language (SQL) compliant database and obtains its data from both the Ships' 3-M and PDREP systems. Future versions of OARS will provide direct access to the PDREP and CDMD-OA systems.

Ship Equipment Attributes - Logistics Information Network (SEA-LINk) - SEA-LINk development has been supported by Advanced Marine Enterprises and NAVSEA 03R3's ATC Program. SEA-LINk is primarily an equipment information database and systems engineering tool. Its purpose is to aid ship design and acquisition teams in the selection of equipment, systems, and components based upon best performance, cost, quality, and logistics supportability. SEA-LINk was developed specifically to address acquisition reform objectives by matching performance requirements with standard and COTS items. It also provides critical cost and logistics information necessary to make "best value" equipment and end item selections during the design and acquisition process. Essential form, fit, function and performance requirements can be listed and "compared" using the "compare to" function with both Navy supported and COTS items contained in the master database. The SEA-LINk system contains unclassified data from the HEDRS, PDREP, CDMD-OA and OARS systems. In addition, SEA-LINk has information regarding COTS equipment, including acquisition and logistics data such as NSN replacement costs and COSAL data. The SEA-LINk system can be used as an effective configuration management tool and was also built with "hotlinks" to manufacturers' Internet and WWW sites to foster quick communication between system engineers and the commercial world. As shown in Figure 6, it is envisioned that SEA-LINk will become an integral component of an electronic (Internet-based) network of shipbuilding data and also be accessible on the NAVSEA Local Area Network (LAN).

DESIGN STANDARDIZATION

An effective means to foster standardization under acquisition reform is to provide design team personnel with clearly defined constraints and selection criteria for use throughout ship design, and to monitor the use of those constraints and selection criteria. Design constraints and selection criteria may include a listing of items that meet design standardization criteria and may also take the form of uniform space allocations and standard interfaces and restrictions upon the population of items available to perform a given function.

Standardization Design Reviews - Standardization personnel should perform standardization design reviews to oversee the requirements for the selection of items developed in accordance with the provisions of the Logistics Support Standardization Plan and to ensure the integrity of that selection throughout the design and procurement process. Standardization reviews should be conducted to ensure that all equipment and components performing a similar function are screened with a view towards settling on a single make and model to perform as many like functions as possible in as many systems as is practicable. If engineering and cost analysis indicates that the available standard is not the best or most effective design choice, non-standard NDI should be used. Nonstandard COTS equipment should only be used for applications where use of the item will significantly reduce total ownership cost through lower acquisition cost, superior reliability and maintainability performance, reduced manning, or some combination of these factors. However, before selecting a COTS item, the cognizant engineer should ensure that there is no standard equipment available which meets the specified performance/design/support requirements that is as attractive from a TOC perspective. Selection of a nonstandard equipment should

offer a significant advantage over all available standard equipment.

Modular Design and Equipment Packaged Units - The objective of applying modularity to the design and construction of ships is to reduce acquisition and total ownership costs through application of fewer, standardized system designs. It is intended that the use of modular construction methodologies will result in improved efficiency in the construction process by reducing the time required for design team efforts, simplifying design methodologies, and minimizing custom design research and development efforts. Modular design and construction methodologies should be used wherever they can be applied to standardize equipment arrangements, space allocations, and system interfaces.

Although it means different things to different people, as used herein the term "modular construction" means designing and fabricating spaces, compartments, systems, or equipment packaged units that represent a grouping of functionally or operationally related items. Modular construction is characterized by the use of standardized structural systems architecture integrated with common equipment, components and piece parts. Module components may be structural elements, such as standardized panel sizes used repeatedly in the fabrication of bulkheads, or standardized units and components grouped and assembled with others of a like kind. Modular-based approaches to standardization provides commonality with other systems and auxiliary service and distributed system interfaces. Modules may take the form of stand-alone, space, compartment, or system modules comprised of standard and common equipment, components, piece parts and auxiliary service interfaces that perform specific functions. Generally, modules are ready for installation, hook-up and operation, or in some cases, may resemble a packaged equipment unit constructed or assembled on a common subbase or foundation comprised of functionally related, standardized equipment and components ready for installation. The vision for the use of module construction and integrated product databases is shown in Figure 7.

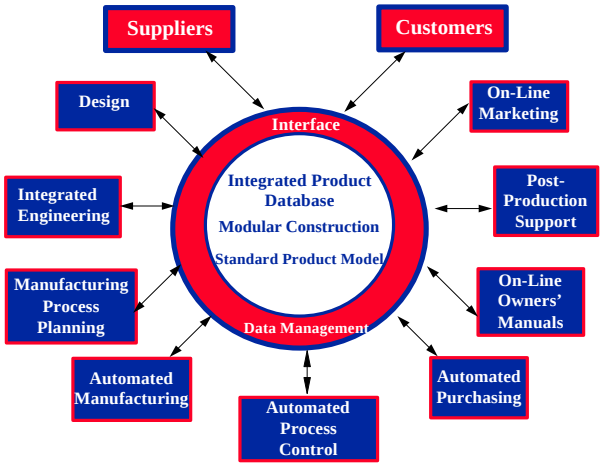

Figure 7- Integrated Product Database

Examples of modules include the ATC-developed crew sanitary space, reverse osmosis, and fire pump modules. Modules are indicative of integrated design solutions that maximize efficiencies that result from applying standardized architectures during ship design and construction. Modular construction and fabrication techniques share the following common elements:

- Capability to be assembled independent of the mainstream ship construction process,
- Comprised of standardized equipment, components and piece parts,
- Are interchangeable with other modules of a like kind,
- Use a common foundation, subbase, skid, or other means of structural support,
- Use common interfaces for shipboard hook-up to distributed services.
- Can be lifted and transported intact to the final installation location, and
- Can be tested off-ship in a commercial facility or workshop environment.

Although using common modules across the fleet restricts optimization of design features for a particular ship design [11], the cost advantages far outweigh the performance tradeoffs. The key elements of effective standardization of module equipment and components is that the final installed product *be* ***affordable, producible, testable, reliable, maintainable, supportable, and upgradable.***

SUMMARY

Standardization under acquisition reform is requiring Navy design and engineering personnel to use new approaches to requirements definition (performance oriented) and equipment selection and life cycle support processes (commercial supply support - quality partnerships with OEMs/vendors). Applied information technologies are increasingly being used to determine best value and total return on investment for COTS items that meet performance requirements. This electronic distribution and dissemination of equipment information now allows NAVSEA to conduct comprehensive market research to determine best value and optimum total ownership cost for many end items. New approaches to computer-aided acquisition and logistics support and a growing awareness that many COTS items are superior (and have reduced acquisition and operating and support costs) to "standard" items are also opening the doors to increased use of a wide range of commercial items. However, preference for use of COTS items does not mean that they should be used in all applications, only ***where it makes sense from a performance and total ownership cost standpoint.***

The use of Integrated Product and Process Teams will result in fewer opportunities for missed or misunderstood communication of equipment and weapons system performance requirements. As NAVSEA takes its position within this new paradigm, a partnership with industry becomes possible as both customers and suppliers strive towards a common set of goals: increased quality and lower total ownership cost. Alternative approaches to integrated logistics and supply support are being implemented as evidenced by the fact that program managers are actively considering contracting with shipbuilders for total ship life cycle support (total services support contracting). Additional benefits of standardization under acquisition reform include greater availability and lower unit prices for equipment and components. DoN requirements that are integrated into commercial production are far more likely to have a stable industrial base to draw from, should there be a need to during time of war. Meeting

standardization goals under acquisition reform is achievable when cognizant personnel are able to apply the newly available technologies and approaches to product acquisition and support that are changing the way the DoN conducts business.

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